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A GEOMETRIC NONSMOOTH MODELLING APPROACH FOR BRAIDING PROCESSES

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The modelling of textile braiding processes on the system level is mainly governed by the intricate kinematics of the bobbin carriers which highly influence the final braid structure. A unified framework capable of modelling the motion of the carriers, of the highly slender yarns as deformable beams and of the contact interactions in overbraiding a mandrel is rarely found in the state-of-the-art due to its inherent complexity.

We propose a novel approach to integrate these modelling aspects in a coherent manner. The yarns are modelled as geometrically exact beams in the framework of the special Euclidean group $SE(3)$ using the model proposed in [1]. Using a similar Lie group approach, we develop a geometrically consistent framework for modelling the carrier kinematics along with their transfers to subsequent horn gears. The kinematic formulation assumes a prescribed angular displacement of the carriers.

The frictionless interaction of the beam with mandrel shall be modelled as a linear complementarity problem for a regular shaped cross-section such as a cylinder. The nonsmooth phenomena induced by the associated unilateral constraints can also be observed at the transfer points of the carriers between horn gears, with jumps in velocities. The nonsmooth generalized-α scheme (NSGA) [2] is adopted for the integration of the nonsmooth equations of motion. This integrator provides a systematic framework for the treatment of the contact problem at position and at velocity levels, which prevents drift issues.

REFERENCES

[1] V. Sonneville, A. Cardona, O. Brüls. Geometrically exact beam finite element formulated on the special Euclidean group $SE(3)$. *Computer Methods in Applied Mechanics and Engineering*, **268**, pp. 451–474, 2014.

[2] A. Cosimo, J. Galvez, F.J. Cavalieri, A. Cardona and O. Brüls. A robust nonsmooth generalized-α scheme for flexible systems with impacts. *Multibody System Dynamics*, **48**, pp. 127–149, 2020.